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RESIDENTIAL CUSTOMER-SITED PHOTOVOLTAICS ~~NICHE~~ MARKETS 1999

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ABSTRACT

Nearly three years ago, the authors published the paper, "Niche Markets for Grid Connected Photovoltaics"[1]. The paper identified target market niches for Customer-Sited Photovoltaics (CSPV), on a state-by-state basis for the United States. The paper demonstrated cost-effective, grid-connected, domestic markets existed and identified those showing the most near-term promise. Many financial and policy attributes effecting the economics of CSPV have changed since the previous paper was published. Incorporating these policy changes into the analysis expands the CSPV market from a niche status to an era of significance. The number of states with break-even turnkey costs (BTC) above four dollars per watt expanded from five to fifteen. The top five state market values are now above a break-even cost of seven dollars per watt, a value at which the domestic CSPV market moves beyond a break-even status to consumer savings or industry profit depending on system price. Emissions mitigation values were also included in the paper, but did not significantly effect the break-even market value results. The paper presents the details of the data, analysis, and results.

1. INTRODUCTION

The domestic market for residential CSPV applications is growing rapidly. Changes and events during the three years since the original niche market analysis [1] include:

- The million solar roofs by 2010 initiative was announced by President Clinton in June 1997 and community partnership commitments are well over the halfway mark, resulting in regional and municipal incentives [2];
- The December 1997, Kyoto, Japan world conference has increased awareness and concern for global climate change;
- Forty utilities are offering or developing green pricing programs;
- Systems benefits charges (SBC) were introduced in nine states, with funding targeted towards CSPV;
- Renewable portfolio standards (RPS) were established in six states;
- Net metering availability has expanded by ten states to a total of 25;
- Utah and New York have introduced new state income tax credits; and
- Mortgage interest rates have fallen and remained low.

The result of these events, when incorporated into a new CSPV analysis, demonstrate there is now more than a niche market.

2. APPROACH

The state-by-state database was developed with the same approach as the original niche market study. It is developed as a weighted average for each state and presented in Table 1.

TABLE 1: STATE-BY STATE ATTRIBUTES AND INCENTIVES

State	Res. Rank 1999	Res. Rate [3]	Res. Tax Credit [4],[5]	Net Meter [6]	Prop-erty Tax [3]	Sales Tax [3]	Buy Down, Grant[5], [7],[8],[9]	SOX-#/kW-yr [10]	NOX-#/kW-yr [10]	CO2-#/kW-yr [10]	Cap Factor [11]	Res. BTC ($/kW) 1999	Ext. - NPV ($/kW) 1999
Alabama	37	6.7						16	8	2937	19	$2,497	$664
Alaska	39	11.4						5	10	2644	12	$2,462	$413
Arizona	14	8.8	25%/$1K	Y		Y		7	10	2957	24	$4,590	$456
Arkansas	34	7.8						7	7	2791	19	$2,542	$434
California	4	11.5		Y	Y		$3/W,50%	2	4	1389	22	$7,402	$286
Colorado	10	7.4		Y			25%	10	16	4122	23	$5,196	$687
Connecticut	19	12.1		Y				6	4	2062	18	$3,531	$319
Delaware	21	9.2						28	10	3503	18	$3,497	$987
Florida	11	8.1				Y	*$2/W*	14	8	2739	19	$5,016	$592
Georgia	30	7.7						17	7	3090	19	$2,798	$687
Hawaii	3	14.8	35%/$1750					15	9	4356	24	$7,911	$737
Idaho	49	5.2						2	1	644	21	$1,690	$110
Illinois	2	10.4			Y		*60%/$5k*	17	8	1962	18	$8,411	$612
Indiana	29	6.9		Y	Y			24	18	4401	17	$2,815	$1,037
Iowa	23	8.2		Y				16	15	3497	19	$2,995	$759
Kansas	26	7.7						9	12	3350	21	$2,894	$576
Kentucky	42	5.6						27	11	2976	17	$2,323	$930
Louisiana	28	7.4						19	8	3206	20	$2,828	$735
Maine	22	12.8		Y				8	3	2767	16	$3,462	$423
Maryland	7	8.3		Y			$2.94/W	17	9	2876	18	$6,133	$693
Massachusetts	13	11.6	15%/$1K	Y	Y	Y		9	5	2408	18	$4,647	$433
Michigan	40	8.6						11	8	2198	16	$2,414	$481
Minnesota	44	7.2		Y	Y	Y		7	10	2909	17	$2,217	$469
Mississippi	36	7.0						11	9	3228	19	$2,502	$581
Missouri	31	7.1						17	12	3165	19	$2,681	$730
Montana	48	6.4			Y			3	6	2017	19	$1,919	$263
Nebraska	43	6.4						8	11	2384	20	$2,222	$453
Nevada	17	8.9		Y				8	13	3714	24	$3,610	$578
New Hamp.	18	13.7		Y	Y			8	2	1230	16	$3,540	$294
New Jersey	6	12.1		Y		Y	$2.94/W	4	6	1912	18	$6,719	$289
New Mexico	16	8.9		Y				9	17	4447	25	$3,860	$684
New York	1	14.1	25%/$3750	Y			50%	6	4	1540	18	$10,257	$289
N. Carolina	5	8.0	40%/$1500	Y			$2.94/W	14	7	2409	19	$7,042	$563
North Dakota	20	6.3	5%-3yrs	Y	Y			15	12	3630	19	$3,519	$710
Ohio	25	8.6						27	11	2714	16	$2,956	$925
Oklahoma	35	6.6		Y				9	12	3509	21	$2,538	$578
Oregon	47	5.6	.40/kWh, $1K					1	1	415	18	$2,042	$55
Pennsylvania	8	9.9		Y			$2.94/W	16	6	1854	16	$6,092	$548
Rhode Island	15	12.1		Y			$1/W	1	9	2262	18	$4,564	$264
S. Carolina	41	7.5						11	5	1738	19	$2,403	$416
South Dakota	46	7.1			Y			5	4	947	19	$2,065	$215
Tennessee	45	6.0						18	7	2223	18	$2,191	$652
Texas	27	7.8		Y	Y			6	9	3166	22	$2,892	$453
Utah	12	6.9	25%/$2K					3	15	4705	24	$4,907	$710
Vermont	32	11.5		Y				0	0	293	16	$2,614	$21
Virginia	9	7.8		Y			$2.94/W	12	6	2443	18	$5,753	$513
Washington	50	5.0		Y				2	1	412	15	$1,020	$81
West Virginia	33	6.3						29	12	3353	17	$2,605	$1,014
Wisconsin	24	6.9		Y	Y		$0.5/kWh	14	10	2896	16	$2,994	$630
Wyoming	38	6.2						8	16	4151	21	$2,477	$641

The analysis approach is also consistent with the original market study, in that the annual cost and benefit cash flows over the life of the system are forced to a net present worth of zero, at an 8% discount rate by varying the initial system cost.

The BTC is the market hurdle value at which the customer neither benefits from savings nor incurs costs over the life of the system.

2.1 Assumptions

Many of the assumptions are different from the original study. The electricity price inflation rate has been lowered from 3.5% to 2%, consistent with market realities. This change decreased the BTC 5-10%. However, operation and maintenance costs are still inflated at 3.5%. An inflation rate was not applied to the environmental externality benefits over the life of the system, since this is still an intangible value. Also consistent with the 1996 analysis is the one kW installed PV system basis, taking advantage of full residential retail electric rate benefits. The mortgage financing is at 90% debt, 30year term, but the interest rate is set at 7% down from 8%, which results in an increased BTC.

2.2 Database Development

2.2.1 Residential Rates

Next to capital cost reduction policy incentives, the analysis is most sensitive to changes in the residential rates. The current residential rates are based on annual residential revenue and consumption [3], resulting in lower more conservative rates. Of the 50 states, only 21 rates changed from the initial study by one- or two-tenths of a cent.

2.2.2 Policy Incentives

Net metering [6], property tax and sales tax [4] incentives are included in the table, but not in the analysis. Full residential electric rate benefits are assumed, due to the BTC per kW installed basis.

The state buy-downs and grants are all new policies, which have developed since the original study. The authors have chosen to include two state (Florida and Illinois) buy-down policies and programs, which are not yet, but will soon be available. However, the actual buy-down may change upon availability. Additionally, the authors were unable to verify the availability of the Colorado Solar Energy Association 25% system cost rebate, but the rebate is included in the analysis.

The California SBC provides $54 million over 4 years for buy-downs of "emerging renewables", which include residential CSPV. The California Energy Commission administers the fund, which started in March of 1998. The buy-down provides $3/W up to 50% of the installed cost. It was designed to decline on an annual basis, but is currently still available at the $3/W value [12].

The Photovoltaic Buildings in Florida program will apply the major portion of $600,000 worth of funding from the Florida Energy Office / Department of Community Affairs towards system buy-downs. The residential CSPV buy-down is proposed at $2/W [8]. The program will be administered by the Florida Solar Energy Center.

The Illinois SBC will collect $5 million annually targeted towards renewable energy resources [5]. The Renewable Energy Resources Program under the Department of Commerce and Community Affairs is expected to administer grants to fund 60% of CSPV costs up to $5,000.

The Virginia Alliance for Solar Energy (VASE) is currently offering a $2.94/W buy-down for residential CSPV in five (Maryland, New Jersey, North Carolina, Pennsylvania and Virginia) states, through a request for proposal [7]. A minimum aggregate of 10kWac is required by the request for proposal.

The New York State Energy Research and Development Authority (NYSERDA) will administer the SBC fund expected to collect over $234 million in the next three years [5]. Currently, NYSERDA has a program opportunity notice (PON) to deploy $1 million funds towards residential CSPV [9]. The PON limits the cost share at 50%.

2.2.3 Environmental Externalities

The pounds per kilowatt-hour emission mitigation for SOX, NOX, and CO2 externalities were determined using the total industry generation and total industry emissions for each state [10]. Due to disclosure conflicts and externalities conflicts, six states, Arizona, Kentucky, Mississippi, Nebraska, North Dakota and Wyoming are calculated using utility generation and total industry emissions. The emissions mitigated for each kW of PV installed are then calculated using the state average PV capacity factor [11]. The value of the emissions mitigation by PV is based on the cost of control [15] versus the value of environmental damages.

TABLE 2: Emissions Cost-of-Control Values

	National [14]	CA [16]	WI [16]	MA 16]
SOX $/#	$2.03	$2.20-11.00	NA	$0.75
NOX $/#	$0.82	$4.50-$15.00	$1.35	$3.25
CO2 $/ton	$13	$9	$15	$22

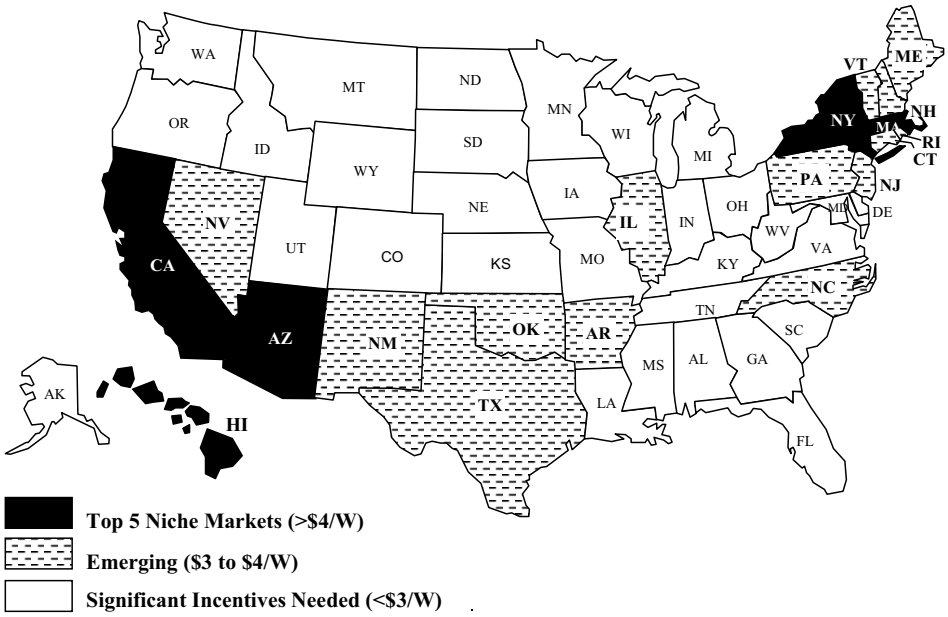

Figure 1 1996 CSPV State-by-State Mapping

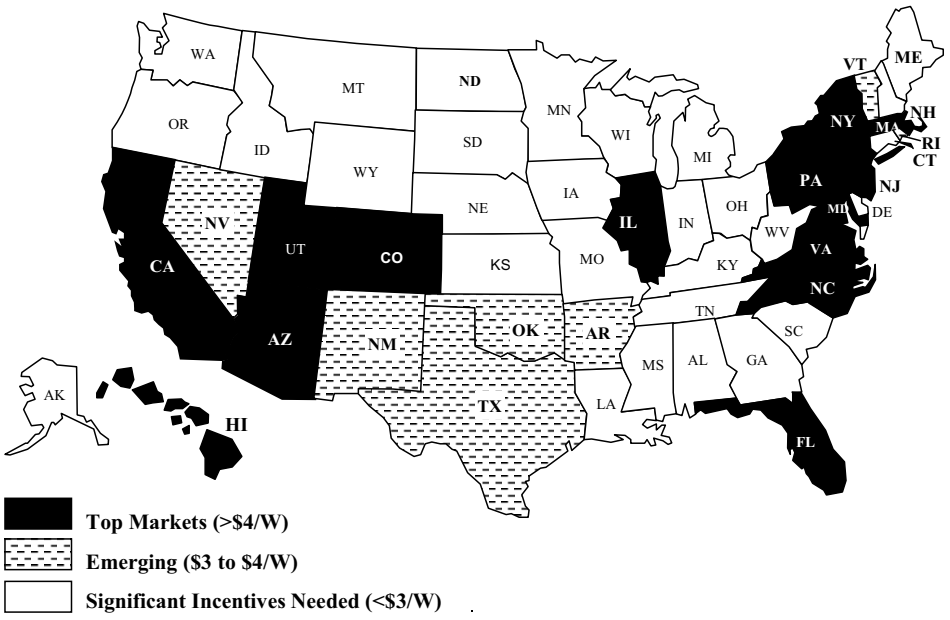

Figure 2: 1999 CSPV State-by-State Mapping

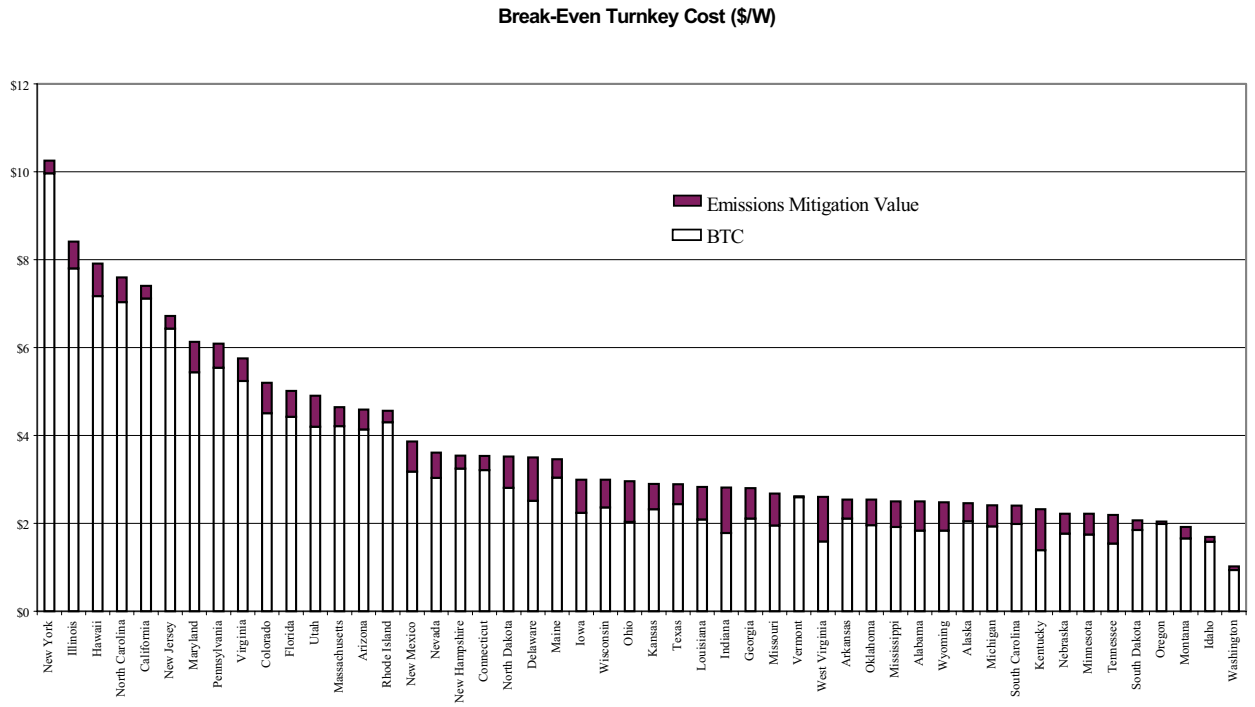

Figure 3: State Ranking of BTC

3. RESULTS

3.1 1996 versus 1999

The differences between figures one and two illustrate the niche market expansion from five to fifteen states. The BTC presented in Table 1 includes the environmental externalities. The bars in Figure 3 are stacked. The same market tier break of $4/W indicates a current and significant CSPV market. The BTC division criteria for current market and emerging market is even more valid considering the most recent price of $4.25/W ($5.07 including SMUD's costs) for the systems installed in Sacramento Municipal Utility District (SMUD) [13]. (These division criteria are $3, $3 to $4, and over $4/W.) Using conservative assumptions and averaged state data, the market has become significant

3.2 Policy Values

All 15 states in the top market tier have tax credits and/or a capital cost reduction policy or program. All 5 states eligible to participate in the VASE partnership now have BTC market values above $4/W. Virginia and Maryland were actually in the lowest tier in the 1996 analysis [1], but jumped to the top market value with the VASE partnership incentive. Even Florida, with its low electric rates, jumped to the top market tier through a minimal $2/W buy-down.

3.3 Environmental Value

The environmental values are not a large portion of the overall BTC. In fact all 15 states remain in the top tier of market value greater than $4/W BTC with the environmental values subtracted. Since the value is currently intangible, the knowledge of emission mitigation quantities has more value as marketing information.

4. CONCLUSIONS

Though the results of the study identify a tremendous market value increase in 10 states, it merely scratches the surface in identifying potential market values and mechanisms.

CSPV capital cost reduction policy incentives continue to be the leading driver for cost-effective domestic markets. System benefit charges resulting from restructuring have spawned a few CSPV market policies. However, it is only the beginning, the SBC deployment mechanisms in Connecticut, Massachusetts, Montana, New Hampshire, and Pennsylvania have not yet been developed. Policies favorable to renewables have been included in all but one of the thirteen states embarking on electric industry restructuring through legislation.

Partnership programs similar to the Virginia Alliance for Solar Energy and the Photovoltaic Buildings in Florida program are emerging across the nation as a result of the Million Solar Roofs Initiative [2]. The increased value of partnerships to a sustainable domestic PV market is two fold. First, the value propositions from several market sectors can combine for a much larger overall market value. These combinations could include tangible financial value through utility distributed generation requirements, green pricing and marketing, state, regional, municipal and industry economic development incentives and mechanisms, or environmental mitigation needs.
Second, infrastructure barriers to rapid market expansion may be the result of inexperience or lack of knowledge, but are the cause of added cost and frustration to consumers [15]. A vested interest may be the driver required for quick education on codes and standards for permitting, grid interconnection, and liability insurance issues.

Even though the market tier thresholds were maintained from the 1996 analysis [1], the current study shows the top five state market values are above $7/W. This is a value at which industry could realize a profit from the domestic market or the consumer could realize savings over the life of the PV system, depending on the price of the system. Furthermore, these are values calculated from data averaged over the state. Targeted analysis of high energy cost regions within these states would yield even more profitable markets.

5. REFERENCES

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